mailing, require a total of slightly over four and one-half hours time.

Due to the successful and extensive development of the vessel weather service comprehensive studies are made of meteorological conditions over the Pacific Ocean. The knowledge of oceanic pressure distribution, the most vital factor in forecasting for the far Western States, becomes available to forecasters. The isobaric reproduction on the synoptic charts of pressure systems as indicated by vessel reports pictures the movements of cyclonic and anticyclonic areas. The continuous eastward march of "HIGHS" and "LOWS" may be closely followed. The constant changing conditions; the rapidity of movement; the relative positions of cyclonic and anticyclonic areas; the intensity of a depression; the steepness of intervening gradients and all the information derived from these factors form the basis for accurate conclusions in forecasting. Without vessel-weather observations forecasters would be confronted with a very puzzling situation.

The value of the forecasting and warnings can not be estimated. Every industry, enterprise, organization, or the individual, whose welfare is affected by weather conditions receives invaluable benefits from this service. Ever increasing demands for a more extensive weather service are taxing the Weather Bureau to capacity. Fairly rapid strides have been made in recent years in the extension of the services of the Weather Bureau and vessel weather reporting has played an important part in the advance.

METEOROLOGICAL NEEDS OF A CLASS A 1 A AIRPORT[1]

551.5 : 725.39

By D. M. LITTLE

The Secretary of Commerce is empowered by law to rate airports as to their suitability upon application of the owner. After conforming to certain basic requirements, airports may be given ratings indicated by a letter, a figure, and another letter, the first letter indicating the general facilities and equipment at the airport, the figure indicating the available landing area, and the last letter indicating the night flying equipment. Thus the rating A 1 A is the highest rating given airports.

Under general facilities and equipment, an airport, in order to obtain a rating of "A" or "B," must have meteorological instruments including an anemometer, barometer, and a thermometer, in addition to a bulletin board and facilities for giving pilots the most recent weather information. Ratings of "C" or "D" do not require meteorological facilities. Under night-flying equipment an airport must have a ceiling projector, an alidade for measuring the height of ceiling, and sufficient personnel for giving weather service at all times in order to receive a rating of "A." A rating of "B" will be given when an airport is without a ceiling projector, and ratings of "C" or "D" may be given when the airport is without night meteorological facilities or personnel.

The meteorological needs of a class A 1 A airport is much greater than the bare requirements for the rating. In this paper the needs are classified under three headings—Personnel and service, Communication facilities, and Meteorological instruments and facilities.

PERSONNEL AND SERVICE

1. *Government service at airports.*—At airports designated as control stations on established commercial airways in use more or less 24 hours per day there are ordinarily not less than four Weather Bureau officials on the meteorological staff—i. e., two meteorologists and two observers. At similar stations on established commercial airways where from 15 to 20 hours' service per day is sufficient for the present flying one meteorologist and two observers are usually assigned. At all other airport stations and aerological stations 12-hour service is maintained by the assignment of one meteorologist and one observer. Employees below the rank of junior observer should not be assigned to airport stations, as the responsibility is too great to be placed with men of lesser capacity. Service at Weather Bureau airport stations is progressing at a fast pace. Experience has shown that close contact between the meteorologist and the pilot is absolutely necessary, and this mutual exchange of meteorological information and flying problems is conducive to safe and economical air transportation.

2. *Municipal service at airports.*—Many large and important municipal airports over the country, located on and adjacent to established airways, will not be needed as Weather Bureau airway control stations, and therefore will be without Government meteorologists. However, Government airway weather and communication service is available at small cost to such airports, but it is necessary for the municipalities to employ their own meteorologists. This has already been done in several instances, and the airports are rendering as efficient service as at the Weather Bureau airport stations.

3. *Service at privately owned airports.*—The need for meteorological service at a privately owned airport where air-transport operations are carried on is just as great as at a municipal airport. Here, again, it will be necessary for the airports or air-transport companies to employ their own meteorologists. In some cases it will be necessary for an air-transport company to employ one or more meteorologists, placing them at strategic points along their particular flying route when such route does not follow the established commercial airway. One company has already set aside $100,000 for its own complete meteorological service along such a route.

Private and municipal airport meteorologists, of course, should be experienced and thoroughly familiar with the aerological, marine, and weather codes of the United States Weather Bureau. With the wealth of information available, as explained later under "Communications," the meteorologist can prepare synoptic maps of 12-hour weather conditions, tabulate and map hourly airway weather reports supplemented with 3-hour summarizations and short-range forecasts based on off airway reports, prepare multilevel maps of upper air winds, and furnish all pilots with current weather reports in tabular form. In addition he would advise the pilot of the best weather route, how high to fly in order to take advantage of "tail winds," and the weather changes to be expected during a flight along an off airway route. In short, he would render for the municipal and privately owned airport all of the service available at a Government station and devote a portion of his time to research on meteorological problems particularly affecting his area.

[1] Presented before the Berkeley meeting of the American Meteorological Society in June, 1929.

COMMUNICATION FACILITIES

At airports where Weather Bureau airport stations are established the Government provides all necessary communication facilities, such as long-distance telephone, telegraph, teletype circuits, and radio stations. Municipal and private airports without such a station can easily avail themselves of all meteorological information. An airport located near a Government airway station where long-line teletype facilities are available can arrange for a drop on the circuit whereby the airport pays for its own drop. Also the installation of an inexpensive short and long wave radio receiving set is essential. Reports transmitted by the Weather Bureau to the Department of Commerce radio station are transmitted on the long-line teletype as well as broadcast by voice. For the preparation of 12-hour synoptic maps and multilevel upper air maps, it will be necessary for the airports to arrange to have an operator copy the Weather Bureau broadcast from the naval radio. An airport complying with the A 1 A requirements needs this tie in with the Government communication system before it can hope to give its pilots the best service obtainable.

METEOROLOGICAL INSTRUMENTS AND FACILITIES

For the larger important airports an ideal instrumental layout is as follows: Pressure tube anemograph, mercurial barometer, high-grade aneroid barometer, barograph, hygrothermograph, psychrometer, maximum minimum and exposed thermometers, rain gage, sunshine recorder, pilot-balloon equipment, ceiling projector with alidade, and an airplane meteorograph. In this list the pressure-tube anemograph was selected in preference to the wind vane, anemometer, and recorder because a record of wind fluctuations and gustiness is needed at important airports. A mercurial barometer is needed for accurate measurements of barometric pressure. A record of temperature and humidity as obtained with a hygrothermograph and psychrometer is important. All airports have more or less fog to contend with during certain periods of the year, and a continuous record of relative humidity and temperature will be useful in research work on this problem. In addition, the dew point of the air is required when giving airway weather reports. A sunshine recorder is of value for records of beginnings and endings of cloudiness or fog at the airport. Pilot-balloon equipment is recommended for airports employing meteorologists, especially where the airport is far removed from a Weather Bureau aerological station. Even if located close to a Weather Bureau aerological station, frequently an observation can not be obtained at the Weather Bureau station because of local low clouds or fog, while an airport meteorological station several miles away could make the observation in a clear sky or vice versa. In one case this is carried on successfully through the Government station advising the municipal station at times when low clouds interfere with the observation at the Government station. The ceiling projector and alidade for measuring the ceiling or altitude of the clouds at night is required for a class A rating. Height of ceiling, a difficult observation at best, is made extremely simple with this equipment. All airports should have this equipment, regardless of whether or not a meteorological station is planned. An airplane meteorograph has been included with the list of meteorological instruments for airports employing meteorologists for the reason that upper air records are badly needed. The airport meteorologist would have little difficulty in securing the pilot's cooperation in this work.

Substitutions and omissions in the above list of instruments may be made, of course, to meet the requirements and budget of each individual airport. The rule to follow in selecting meteorological instruments is to begin with the basic requirements of an "A" rating and substitute or supplement with self-recording instruments as far as possible.

Under "Facilities" an airport should provide space and office equipment for a meteorological office in the administration building. The office should contain a bulletin board showing current upper-air wind data from surrounding aerological stations, United States Weather Bureau airway forecasts, current airway weather reports, and a daily weather map. Wall maps, topographic maps, and airway strip maps are desirable in the meteorological office.

It is interesting to note that one after another of the problems affecting commercial aviation have been overcome; motors have been developed to the point where with proper care seldom is there a complete failure; instruments have been developed and improved; pilots are becoming more and more experienced; planes have been improved for speed and safety; and now one of the vital problems affecting commercial aviation—i. e., the weather problem—is being investigated and minimized by the installation of meteorological instruments, by fast communication service, by the tie in of airports with the Government airway meteorological and communication system, and by the employment of meteorologists at airports.

551.515(73)

WHAT A TORNADO LOOKS LIKE

By S. D. FLORA

A well-developed tornado is the most amazing and terrifying atmospheric phenomenon ever seen in inland America. The first sight of one at a distance—and a hundred or more occur each year in the country—gives the impression of a contradiction of nature's laws that permits such a storm to form at all. As it approaches with its peculiar whistling sound that rapidly changes to a terrific roar and buildings are blown to pieces as though they were made of cards, the effect is enough to strike terror in the stoutest of hearts.

Contrary to the popular idea, a tornado seldom gives the impression of a huge inverted funnel. It has been more commonly described by eyewitnesses as a gigantic elephant trunk writhing about or a long rope dangling from the sky that spreads destruction where ever it touches the ground.

One of the most spectacular tornadoes on record struck the edge of Hardtner, Kans., about 5:15 p. m. of June 2, 1929. The sky was only partly overcast at the time and the sun shone full on the pendant cloud, making it a striking sight for 30 miles across the almost level country adjoining. Instead of moving at express-train speed, as tornadoes generally do, this one seemed to loiter and remain almost stationary for the greater part of half an hour.

In describing it an eye witness said, "If you can imagine a big, gray elephant trunk or sausage balloon strung across the town with the upper end in the clouds